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CYMATHERE, A KELP FROM THE WESTERN COAST.*

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Cymathere is a genus of the Laminariaceae established by J. G. Agardh '67 to receive the older *Laminaria triplicata* of Postels and Ruprecht '40. Though De Toni '95 includes in it *Laminaria crassifolia* which has a branching holdfast, the genus is monotypic. Its sole species, *Cymathere triplicata*, is confined to the northern portion of the Pacific Ocean. It grows abundantly at the Minnesota Seaside Station on Vancouver's Island where the plants herein described were collected.

In its habitat Cymathere is the antithesis of such kelps as Postelsia and Lessoniopsis. Far from seeking the buffets of the surf, it retires into secluded nooks where the surge of the waves is no more than a gentle swishing to and fro. It does not succeed well except in situations which are never uncovered by the tides. On this account the juvenile forms are difficult to obtain by the more usual methods of collecting. Those gathered by the writer were secured by picking out of a pothole, in which the adult plants were flourishing, a number of stones as large as could be lifted easily. Search of these with a hand lens at leisure in the laboratory disclosed plants of all ages, down to the smallest obtained.

At its maximum size the narrow oblong lamina of Cymathere may reach a length of 4 meters and a breadth of 22 cm. No single specimen was seen, however, in which both these extreme dimensions were present. Most of the plants are quite narrow, only about half as wide as the broadest, which are very short with plicae very much broadened and less prominent than in narrower individuals. The base is cunate or rounded, narrower in young specimens and broadening afterwards as Yendo '03 has shown to be the case in *Hirome undarioides*. At the tip

* Contributions from the Botanical Laboratory of the Ohio State University, XXIX.

the plicae are the last portions to be eroded away and hence they frequently stand out as long acuminations beyond the blade proper. The stipe is exceedingly short for so large a plant, seldom if ever exceeding 5 cm. The holdfast has no hapteres rising from the stipe but instead consists simply of the primitive disc, which becomes about 3 cm. in diameter covering thus a very much smaller area than the holdfast of those kelps which have a number of hapteres to increase the strength of their hold on the rocks. As in Renfrewia the surface of the primitive disc (not the stipe above) is subject to local secondary growth by which means branches are formed which pass outward and strengthen the holdfast. These are, however, so flat and so closely appressed to the disc that they are not noticeable except in sections, (See figure of Renfrewia, Postelsia 1906: Pl. 18.)

Specimens in fruit are not easy to find at Port Renfrew during the summer season. Late in the season, however, in old plants may be found at the base of the lamina on both sides, the lanceolate fruiting patches. Proximally they may extend to within a millimeter of the base of the lamina following its margin around till its full width is attained at which point they suddenly narrow to the plicae up which they extend for a distance of about 25 cm., making the whole sorus 40–50 cm. long. At its tip the fructiferous area extends much further up in the grooves than on the ridges of the plicae, thus forming on one side three and on the other two or four acuminate points 5–25 cm. long.

It will be of interest to compare the positions of the sori in Cymathere and such kelps as Nereocystis. In the latter the gonidia are born out near the tips of the branches perhaps a hundred feet from the attachment of the holdfast. Instead of maturing in one definite short season as seems most likely to be the case with Cymathere, they are borne continuously from the time the plant becomes mature till it is torn up by the waves. When liberated the zoospores must be carried long distances by the waves, in addition to the space they traverse by their own activity, before they settle down to the substratum. But in Cymathere, growing in relatively quiet water, they are set free within a few inches of the station of the parent plant and might be expected to settle close around it. The habit of the one would be most favorable for wide dispersal but only a very small proportion of the reproductive bodies would succeed in establishing themselves in favorable situations. The other would be slower in dispersing itself but a larger percentage of the spores would start favorably. These inferences are well borne out by the facts of the distribution of the young of the two species. Nereocystis, it will be recalled, thrives only in the deep water off shore where it is able to reach the surface with its long stipe. But on

a coast where it is well developed its young plants may be seen everywhere between the tide marks even up as high as any of the kelps grow, where they must soon perish because of the unsuitable conditions. They are much the most abundant of all the young kelps to be found even in high levels. The young of Cymathere though it grows much closer to the tideline than Nereocystis, are not often found growing uncovered at low water and are very much less abundant though the adults are by no means scarce at Port Renfrew.

In its histology Cymathere offers some points of interest. As to the presence or absence of mucilage ducts there seems to be some question since De Toni '95 contradicts Kjellman '93 by asserting that they are present. In the specimens which I have examined the stipe is wholly without ducts of any kind, while in the lamina there occurs an irregular circle of openings which may be considered mucilage ducts. But they are not definitely developed tubules with a lining wall of special secreting cells as MacMillan '99 reports in Nereocystis; nor are they in a closely crowded circle of definite position as in *Laminaria bongardiana* or in *L. bullata* as figured by Miss Mueller '04, fig. 8. They appear rather as a local gelatinization and breaking down of certain cells, perhaps the beginning of degeneration. To the writer it seems most likely that their presence or absence is a very variable character which might not appear in younger,more vigorous material. This if true would explain the disagreement of the authorities cited. A similar breaking down of certain cells may sometimes occur in *Renfrewia parvula* but very much less abundantly. In this case I did not consider the cavities thus formed mucilage ducts because they seemed simply pathological alterations of the tissues and not normal occurrences.

In places the inner cortex is developed into thick walled strengthening tissue as is usual in the family. It is of such sclerenchyma that the ribs on the folds are formed and to it they owe their strength. The greater thickness of the ribs beyond that of the rest of the lamina is entirely due to the extra development of this tissue.

The development of the sporangia follows closely that of other kelps. MacMillan's '99 figures of the early stages of their development in Nereocystis might almost bave been drawn from my own preparations of Cymatheré. The separation of the pellicle from the sorus takes place after the following fashion: The outer cell walls of the epidermis of the unaltered lamina form a rather thick cuticle over the surface. When the epidermis divides into the two layers which go to form the paraphyses and the sporangia, the daughter cells secrete for themselves new cell walls, at least on the external and lateral faces, leaving the old cuticle with the partitions between the cells, free and hanging to the lamina only by the bases of the latter. On the elongation of the paraphyses these connections are broken and the

pellicle is sloughed off. As in other kelps the sporangia do not develop simultaneously but one finds on sectioning a fruiting lamina (fig. 1 *a*), by the side of those which are nearly mature, many others much shorter and younger. The paraphyses, in the material studied, do not conform to the usual type in the Laminariaceae and instead of being clavate with heavy gelatinous tips are linear and without any thickening of the wall at the tip. Their chloroplasts are localized at a point a little back from the colorless tip forming a definite brown stratum above the tops of the sporangia. The discovery of such a character in Cymathere is somewhat of a surprise for it was expected that the genus was like Laminaria in this respect, a fact which lead Kjellman '93 to ascribe to it in his key, the usual clavate paraphyses.

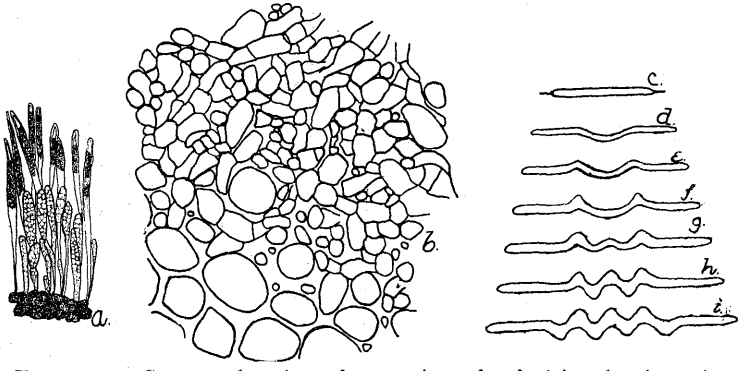


FIG. 1. *a.* Camera drawing of a portion of a fruiting lamina, showing sporangia and paraphyses. X 110. *b.* Camera drawing of a portion of a cross section of a stipe showing pith web and sclerenchyma. X 110. *e–i.* Diagramatic cross sections of the lamina to show the development of the plicae.

In respect to the development of the pithweb Cymathere shows a great resemblance to *Renfrewia parvula*, contrasting strongly with the Laminarias as exemplified by *L. bongardiana*. The hyphal elements are very short, composed of short cells. Trumpet hyphae are very scarce and poorly developed (fig. 1 *b*). In this respect this genus is very much less highly developed than most of the Laminariaceae.

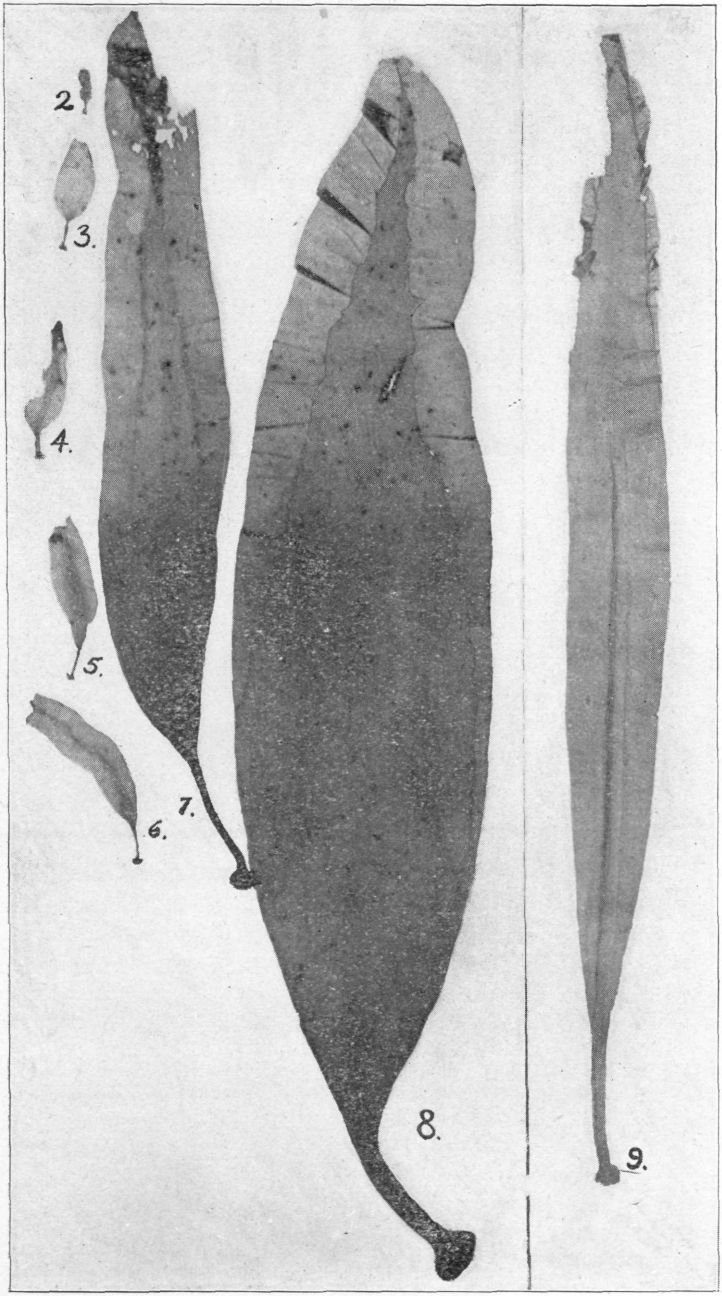
The smallest specimen (fig. 2) of Cymathere found measures about 2 mm. in length. The identification of specimens of this size is, however, somewhat uncertain for I know no character to differentiate them from other kelps when so young. In this specimen the lamina is plane, only one cell in thickness, and oval in shape. The stipe is about half as long as the lamina and several cells thick; in its centre can be seen with a hand lens a faint narrow longitudinal streak composed of longer cells which probably become the pith web. The holdfast of course is the primitive disc.

The smallest specimen which could be certainly identified was about 7 mm. long (fig. 4). In this the stipe was only very slightly longer than in the smaller specimen, being still less than a millimeter while the lamina had become much longer. From this period on through life the species is characterized by a long narrow lamina on a very short stipe. In the center of the lamina has appeared a band of tissue several cells in thickness, which extends from the transition region, where it narrows into the stipe, in an oblong patch through the middle of the blade to within about 2 mm. of the tip.

This thicker area soon cuts off and separates the original thinner portion from the growing point in the transition region and pushes it out into the end of the lamina. This action does not, however, as might be supposed, presage the speedy disappearance of the primitive thin region. On the contrary it shows itself able to make good the waste of erosion for a long time and even increases very much in size. At the first appearance of the thicker band its area is only about 6 sq. mm. while in a specimen about 5 cm. long (fig. 8) it covers 180 sq. mm. forming a wide ruffle all around the tip of the lamina. It continues to be found on specimens even longer than 200 mm. (225 is the longest of such in my collection) but greatly eroded though still giving evidence of continued growth. The presence of a lamina one cell in thickness has been noticed by Setchell '05 who gives a summary of the cases in which it is known to occur. These are *Laminaria saccharina*, *Saccorhiza dermatodea* (Setchell '91) and *Alaria esculenta* all of which Setchell himself has seen, though the case of Laminaria was earlier described by Reinke and perhaps by Kuetzing whose determination, however, Setchell questions. From these cases Setchell infers that such a stage is common to all of the Laminariaceae. Though not so described by MacMillan '99, Nereocystis has the same manner of growth. The writer has in his collection a plant 4 cm. in length in which the pneumatocyst is just beginning to show as a darkened area slightly different to the touch, and a very faint short depression already marks the beginning of the first split. In this specimen there is a margin extending around the tip and half way down the blade about 1 mm. wide, of thin tissue exactly as in Cymathere. In Saccorhiza as figured by Setchell '91, the primitive blade persists only till the plant is about 7 cm. long. I am indebted to Professor Setchell for the information that nearly all the plants from the northwest coast labelled by Harvey *Alaria marginata* are young specimens of Cymathere, a designation which may well have been suggested by the long persisting remannts of the embryonic lamina. All this would indicate that the large size attained by the one layered lamina in Cymathere is quite exceptional.

The first indications of the folding characteristic of the genus appear in a specimen 45 mm. long. The exact manner of the folding can not be well made out at first but in a specimen a little larger, where it is more extended, it is seen to consist of a faint downward bending into a groove in the middle of the lamina (fig. 1*d*). By extending a little beyond the plane of the lamina, at its edges this groove next originates beside it two lateral ridges (fig. 1*e*). At first faint, these are soon made prominent by thickening and the formation of sclerenchyma along their length (figs. 1*f* and 9). In specimens about 20 cm. long the first indications of the third ridge begin to appear in the flattening and finally in the bending upward of the middle of the original median groove (fig. 1*g*). This appears most prominently in the middle of the lamina and fades out both toward the tip and base, a condition which obtains even in specimens half a meter long, in which the third ridge does not attain its full development for a distance of 10 cm. from the base; and even in large specimens the two lateral ridges may extend closer to the base than does the central. Gradually, however, it also extends downward till this indication of its later origin is lost. Meanwhile this ridge is thickened and strengthened (fig. 1*h*) as were the first two; and the grooves between it and the lateral ridges have given rise to two more ridges on the reverse side of the lamina which are in turn similarly thickened. Just as the edges of the first groove made the two lateral ridges, so the edges of these may bend down beyond the plane of the lamina forming on the reverse side two additional ridges which may be thickened (fig. 1*i*) so that the lamina has sometimes three and four ribs instead of three and two. This condition I have seen only in a very old specimen toward the base; at the tip the extra ribs faded out showing in the process all transitions and clearly indicating the manner of their formation.

This study would seem to show that Cymathere is not like Pleurophycus, as might have been supposed, probably a derivative of the Laminarias by the development of the folds in the lamina. Its simple holdfast seems to be the external indication of a structure in all respects simple and low in the scale, though not necessarily primitive. Its linear unthickened paraphyses together with the poor development of mucilage ducts and pith-web would indicate that like Saccorhiza and Phyllaria it probably branched off from the main phylum of the Laminariaceae before the habit of producing clavate thickened paraphyses and a holdfast of secondary hapteres became ineradicably fixed as it is in the higher kelps. In its development nothing noteworthy was found except the very long persistance and large size of the primary one-layered lamina, a character, the significance of which in the phylogeny, I am not prepared at this time to estimate.



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EXPLANATION OF PLATE VII.

Photographs of juvenile forms of Cymathere triplicata taken by transmitted light. Figures 2–8 about three times natural size brightened in places with a pencil to bring out the contrast. Figure 9 natural size also slightly retouched.

Fig. 2. The smallest specimen found.

Fig. 3. The largest before the appearance of the adult lamina

Fig. 4. The first appearance of the several layered lamina.

Figs. 5–8. Progressive series up to the beginning of the folding which has just commended in fig. 8.

Fig. 9. A specimen showing the two ribbed condition; the original groove between them has not yet begun to flatten to form the third ridge; at the tip are the remnants of the embryonic lamina.